

Progress Report submitted to NOAA HDGCR Program

Project Title: Pilot Studies to Evaluate Interpretation Methods, Intermediary Effectiveness, and Appropriate Levels of Intervention in the Provision of Climate Forecasts in the Sahel-Sudan: Climate Forecasting for Agricultural Resources (CFAR) Project-Phase 2

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I. Preliminary Materials

A. Project Abstract: The Sahel-Sudan region of Africa is one of the poorest areas of the world, whose economy depends mostly on rainfed crop and livestock agriculture. The region is an area that stands to benefit significantly from the appropriate application of climate forecast information to improve decisions affecting agricultural productivity and sustainability. Over the past decade, advances in climate models of international organizations have dramatically improved the skill of climate precipitation forecasts for broad regions of the Sahel-Sudan. The National Meteorological Services of individual countries have also developed forecasts for their specific agro-ecological zones. In 1997 Tufts University and the University of Georgia started the Climate Forecasting for Agricultural Resources (CFAR) Project, a multidisciplinary project with the goal of assessing how farmers (both agriculturists and pastoralists) in Burkina Faso can use climate forecasts to enhance agricultural sustainability and food security. We have described the complex of biological, physical, economic and sociocultural factors that farmers consider in devising potential response strategies to forecasts. We, like other researchers, have also found that the greatest challenge to achieving benefits from climate forecasts is communicating the right information to farmers at the right time so that farmers can correctly interpret the forecast and apply it in their decision-making.

This challenge is addressed in this 3-year research project starting in 2002 through pilot studies in Burkina Faso of farm-level application of climate forecasting. We seek to answer three major questions regarding the application of climate forecasts for improved livelihoods and sustainability of agricultural systems in the Sahel-Sudan: 1) How can we best explain scientific information to farmers? 2) What additional information or resources must accompany a forecast, and how should such information and resources be made available to farmers? 3) What is the optimum role of intermediaries in forecast dissemination?

In order to answer these questions we have five **objectives**: 1) To develop methods that best explain and interpret forecasts for farmers; 2) To test different intervention strategies to assist farmers in developing improved methods to manage agricultural resources in response to climate forecasts; 3) To provide feedback to climate forecast and communication organizations on forecast needs; 4) To implement newly developed forecast products as appropriate for farm-level use; 5) To integrate and coordinate with other programs related to improving agriculture in the Sahel-Sudan.

B. Objectives: See above.

C. Approach: We continue to focus on farmers, including agriculturists and pastoralists, in the three main agro-ecological zones of Burkina Faso, which represent three distinct livelihood systems: 1) agro-pastoralism in the Sahel; 2) subsistence grain farming in the Central Plateau; and 3) commercial cotton production in the Southwest.

In each zone we study three villages (Levels 1, 2, 3), which have different levels of experience with forecast dissemination and of extension or development support, with Level 1 representing the minimum level and Level 3 representing the highest level of interaction (these villages have been part of Phase 1 of the CFAR project, beginning in 1998, and have received the seasonal rainfall forecasts for 3 farming seasons). Village 3 farmers have also been organized to take advantage of lead farmers who serve as intermediaries between farmers and project experts (facilitators, meteorologists and agronomists). A set of 6-7 farmers in each of the 3 villages (Levels 1, 2, 3) in each zone have been trained and equipped to collect rainfall data and maintain test plots to generate data for modeling purposes.

We document farmers' understanding and use of, and their responses to forecasts and related information during on-farm evaluations during the farming season as well as post-harvest.

D. Matching Funds: No matching funds were applied to this project.

II. Interactions

A. Collaborators and Decision-Makers: From the start of the research, our partners in Burkina Faso have been the Direction de la Météorologie Nationale (DMN), the National Agricultural Research Service (INERA), and Plan International, one of the largest development NGOs operating in Burkina Faso. The DMN develops the forecasts for the three main climatic zones of the country. They also participated in the workshops by presenting the forecasts to the farmers. INERA's role is to discuss the farming implications of the forecast at the workshops and, having been trained in crop modeling, to add the crop modeling component to the forecast interpretation and value. Plan International provides logistical support and communications with communities in its areas of intervention. As full research partners the DMN and INERA participate in all aspects of the project, including development of tools for research and communication, planning workshops and research activities, and assessing quality of data collected and functionality of

instruments. Collaborators from DMN and INERA conducted a quality assurance and follow up field trip to the three zones in August 2003.

Provincial-level representatives of technical services (Ministries of Agriculture, Livestock, Environment) and other local level stakeholders (representatives of NGOs, farmers' organizations, agribusiness, etc.) participate in the forecast dissemination workshops and are regularly kept informed of research activities and results by the CFAR team and facilitators. In 2003, the Director of the DMN participated for the full two days of the workshop in the Southwest. The elected representative to the National Assembly for the Namentenga Province (where the CFAR sites are located) attended the workshop in the Central Plateau.

On July 1st 2003 CFAR researchers, facilitators, and DMN and INERA collaborators presented preliminary findings at a research seminar hosted by the INERA headquarters in Ouagadougou. The program included presentations by Carla Roncoli on the CFAR project and the recently completed workshops; Didier Ouédraogo (DMN) on the development of a West Africa seasonal rainfall forecast; and Moussa Sanon (INERA) on the potential role of crop modeling in forecast application. The seminar, which was attended by the INERA Director General, the Deputy Director, and several INERA scientists, generated much interest. Copies of the Power Point presentations and overheads were shared with INERA and DMN.

B. *Forecasting Community:* We have been actively disseminating research findings to ACMAD, AGRHYMET, and other regional institutions. Representatives of these agencies will be invited to the end-of-project workshop in 2005. The workshop objective is to summarize current knowledge in the Sahel-Sudan, including Senegal, Mauritania, Mali, Burkina Faso, Niger, Chad, and Central African Republic, with regard to communication and interpretation of climate forecasts, and interventions needed for farmers to apply climate forecasts. The workshop will review results of CFAR pilot projects in Burkina Faso along with experiences of other projects in the region. An output of the workshop will be a document identifying regional and country-specific needs to improve dissemination and application of climate forecasts

C. *Coordination with Other NOAA HD Projects:* CFAR researchers provided the DMN with technical support in planning a national workshop on Dissemination and Application of Seasonal Rainfall Forecasts, funded by OGP Africa Program. The workshop was held in Ouagadougou on October 16-17, 2003 and was attended by about 75 participants, including high level decision makers representing government agencies, international organizations, research institutions, agricultural extension, early warning systems, NGOs, agri-business (e.g., SOFITEX) farmers' associations, and representatives of the Meteorological Services of Niger and Mali. CFAR facilitators and two (male and female) farmers from each of the CFAR sites also participated in the workshop. One of the workshop recommendations was the extension of CFAR forecast dissemination activities to all provinces in the country.

The CFAR project has been providing technical and institutional support to Colin West, a doctoral student of OGP PI Tim Finan (University of Arizona) who is currently conducting research on the relationship between climate variability and household food management strategies in Burkina Faso. Dr. Roncoli serves as an advisor on Colin's dissertation committee and provides feedback on methodology and research instruments.

We have provided feedback on IRI projects and papers and we continue to formally and informally interact with many colleagues from the HD NOAA community by comparing data, sharing information, comparing survey instruments, and discussing findings.

The CFAR Project is also serving as a test-bed for the development of project websites by OGP. Here we are working with OPG employee Patricia McBride.

D. *Other*: CFAR research findings were used in a UNICEF/CIDA report on adaptations to climate change prepared by Dean Pallen and entitled “*Children in the Era of Climate Change: Focus on Africa*”. The purpose of the report is to promote better understanding of the multitude of ways that children in developing countries, and in Africa in particular, are and will be increasingly vulnerable to climate change. CFAR’s work was used to document the centrality of climate in local food production systems and the additional stresses caused by climate variability/change as well as to illustrate the ingenuity of small scale African farmers in producing food and meeting livelihood needs in highly challenging circumstances. The focus on agriculture practices fits into a larger discussion regarding food and security, relative to growing number of environmental refugees throughout Africa. The report is due for release by mid-2004.

As a way to ‘give back’ to the local community, for the last three years (2001-2004) Dr. Roncoli has assisted a women’s association in Dori in obtaining grants from the Global Fund for Women for literacy training in Fulfulde and microcredit for livestock production (according to the priority needs expressed by the women). Dr. Jost and two of her veterinary medicine students from Tufts University offered a workshop on animal health held on June 26th 2003. The association includes about 60 women of different ages, ethnicities, and marital status. Literacy has helped women better understand and retain information, including meteorological forecasts and technical training. Microcredit has enabled women to engage in income generating activities and to use their revenues to buy food, helping their households cope with climate-derived food insecurity. Literacy and earnings contributed to improving women’s status within their households.

Dr. Jost of Tufts Veterinary School will begin a USFWS funded project in July 2004 to develop an elephant monitoring database for the Arli National Park and its buffer zones in Burkina, in collaboration with the University of Bobo-Dioulasso and the IUCN. Included in this system will be sociological data on natural resources use and conflict, including scarcities such as water and fertile soil. Advised by CFAR hydrologist Dr. Kirshen, students working on the project from Tufts and the University of Bobo-Dioulasso have included in their preliminary database the documentation of water and soil resources using GPS, and changing use patterns.

Rainfall data provided by the DMN has been used in a database on pastoral change and the environment in northern Burkina Faso.

Environmental and livelihood data from the region are also being used as the test case for a model of Central Plateau farmer decision-making being developed by a Tufts Civil and Environmental Engineering graduate student.

Initial crop modeling activities, including preparation of input data to define local weather and soil conditions and management scenarios, were coordinated with an AID funded project on Sustainable Agriculture and Natural Resource Management in Mali. Long-term crop rotation data for sorghum-millet-maize-peanut-cotton farming systems were obtained from Dr. Vincent Bado, a soil scientist with INERA in stationed in Bobo-Dioulasso.

Dr. Hoogenboom has joined the Southeast Climate Consortium (SECC), a Regional Integrated Sciences and Assessments (RISA) project funded by NOAA-OGP. The crop modeling tools in the SECC are identical to the crop modeling tools and decision support systems used in the CFAR project. It is expected that the activities of both projects can complement each other. Dr.

Keith Ingram, previously associated with CFAR, was appointed as Coordinator of the SECC on January 1, 2004.

III. Accomplishments.

A. Research Tasks Completed:

Forecast dissemination:

Farmers' workshops:

Forecast dissemination workshops were held at the village level in both the Southwest and Central Plateau, respectively in Bouahoun (June 12-13), Bonam (June 19-20). These villages were chosen because they occupy a central position with respect to the other two villages, and also because, as Level 3 villages, CFAR has been working there the longest and has developed good relationships with the community. In the Sahel, a workshop was held in the provincial center Dori (June 23-24) because no village occupies a central position easily accessible by farmers from the other two villages. The workshops in Bouahoun and Bonam were held in a village community center, while in Dori it took place in the training center of an NGO.

About 10-15 farmers from each of the 3 villages in the Sahel, Central Plateau, and Southwest participated in the workshops (a total of 35-40 per workshop). They were selected jointly by facilitators with village chiefs, administrative leaders (delegué), and key farmers with whom CFAR has been working for some time. Participants included women, herders, and immigrants. The participant selection process had been previously revised and more precise selection criteria were developed to avoid the problems that had occurred the previous year in a few villages, where Peul herders were excluded from participating or local politics interfered in the choice of participants. For this second dissemination, farmers from villages Levels 2 and 3 villages requested that farmers from Level 1 villages be included in the workshop. Therefore, farmers from Level 1 villages also participated in the 2003 workshops.

In addition to CFAR researchers (Carla Roncoli, Christine Jost, Paul Kirshen) and facilitators, collaborators from INERA (Moussa Sanon) and from the DMN (Didier Ouédraogo, climatologist, and Ciriaque Sia, agro-meteorologist) led the different sessions of the workshops.

The workshop unfolded over two days, with its schedule adjusting to weather conditions, religious observance, and other elements. The program included the following components:

- Discussion of what farmers remembered from last year's forecast (CFAR facilitator).

Generally, the 2002 forecast was perceived to have been accurate, as it indicated the probability for higher than average rainfall and indeed rains were good in most sites. Farmers were relieved when they heard the forecast, because they feared a drought, on the basis of the late onset of the rains (timing of onset being a key prediction parameter for farmers). The forecast encouraged them to continue planting. However, there was considerable spatial-temporal variability, which meant that some areas received good rains, while others did not.

- Elicitation of farmers' local forecasts for the upcoming season (CFAR facilitator or DMN), including these questions: a) did all signs point to one scenario, or are there contradictions between indicators? and b) did all participants expect the same rainfall scenario or are there differences among various social groups (i.e. farmers, herders)?

Discussion of farmers' expectations was more productive and animated when it was done upfront rather than after the presentation of the scientific forecast. Generally farmers in all three sites

expected a good rainy season, on accounts of the early onset and of others indicators. In some areas, however, indicators were not consistent, some pointing to the possibility of drought. This discordance was used to explain that the scientific forecast also was somewhat ambiguous, with no clear tendency towards one scenario.

- *Explanation of how the forecasts are produced* (DMN), including a) the point that forecasts are the result of collective work by several African countries; and b) that forecasts draw from observations of rainfall for many years; and c) that forecasts are based on sea temperatures (this seems easy for farmers to understand because they also relate rainfall forecasts to temperature and understand there is a relationship between the sea and rainfall, expressed in terms of manifestations of eastward blowing winds).

This explanation was added in 2003 because many farmers who had participated in the 2002 workshop mentioned that, in disseminating the forecast to their communities, people asked how the forecasts had been produced. They felt that the forecast credibility would be enhanced if they could explain on what basis the information had been based.

- *Parameters and limitations of the forecast* (DMN), including a) that forecasts refer to total seasonal quantity, not distribution (this was exemplified by filling a number of cups of water, representing rainy days, and then pouring everything into a basin, representing the season); b) that forecast do not predict the date of onset and end of the rainy season (the most important parameters for farmers' decision-making); c) that 'seasonal' means during the three months of July, August, and September because that is when most of the rain falls (local calendar is based on lunar months, but we referred to the three months that follow the workshop, more or less); d) that forecasts are for zones and not villages (farmers had no difficulty grasping this notion, but in some cases it got mixed up with the notion of probability, that is 'probability' was understood in terms of spatial variability).

Considerable effort was directed to rectify previous misunderstanding concerning the fact that the forecast relates to the three months of July, August, and September (i.e. farmers had previously understood that the forecast indicated the rainy season will last three months or that it will rain until the end of September). Farmers from Village 3, where forecasts have been disseminated for the last three years, were clearly more able to understand the parameters and probability factors than those in the Villages 1 and 2.

- *Provision of the forecast for the 2003 rainy season* (DMN), including a) explanation of the notion of 'terciles' and 'normal' (this was exemplified by a drawing of a herd walking in line, as they often do in the Sahel: if all animals are ranked from biggest to smallest and the line is cut into three groups, the middle rank constitute the 'normal'); and b) explanation of 'probability distribution' (see below).

In terms of probability, the 2003 forecast presented the challenge of not indicating a clear tendency (30/40/30). This was translated as "expecting a normal season, but keeping in mind the possibility that the season may also be drier or wetter than normal" and with a recommendation to be cautious and prepared for different outcomes.

The idea of probability distribution was explained with a practical exercise exemplifying strong and weak probability: a farmer is getting ready to go to the market to sell a chicken, he approaches his chicken coop, which contains chickens of different colors, and grabs a bird at random. In a strong probability scenario, the chicken coop would host 10 chickens of which 1 black, 2 white, and 7 red (in this case farmers understood well that the red chicken are more likely

to be picked because there are more of them). In a weak tendency scenario, the farmer would have 10 chickens, of which 3 black, 4 white, 3 red, and therefore the probability of picking any color is almost equal. The exercise was repeated several times to show that even a low probability outcome can occur.

These examples, drawn from farmers' daily experience, were much more effective in engaging farmers' interest and enabling them to understand the probability distribution than previous attempts based on teaching tools (color squares or spinning wheel) which we tested in 2002. Farmers remembered the game but not the meaning it intended to convey. This is probably because those tools were developed out of context and did not correspond to farmers' own experience or their learning styles. Moreover, the fact that they resembled children's games or the 'lottery' tricks played at markets by swindlers meant that they were not taken very seriously.

- *Comparison of seasonal forecasts and actual rainfall from the last five years (DMN)*, including a) the seasonal forecast; and b) the actual seasonal rainfall for each year, showing that higher probability in the upper tercile does not necessarily mean a lot of rain, or that 'normal' does not always mean sufficient rainfall. Farmers' perceptions of rainfall for each year were also elicited. The discussion confirmed that farmers' perception of whether a year is average, less or above average, are tied to crop production, livestock health, and water availability rather than measures of rain quantity.

- *Elicitation of response strategies for crop and livestock production (INERA)*, with farmers explaining how they could use the information provided given the resources available to them. A difficulty encountered was the tendency of technicians to shift into an 'extension' mode, promoting improved crop or livestock management techniques, rather than simply soliciting farmers' ideas. While advising farmers on improved management is laudable and often necessary from a development point of view, it also tends to bias farmers' responses during subsequent surveys (farmers dutifully report implementing the recommended techniques in response to the forecast rather than telling us what they actually did or did not do). Technicians' criticism of local management practices triggered reactions, ranging from good-humored customary inter-ethnic joking to acrimonious expression of latent tensions. In the Central Plateau, for instance, herders strongly reacted to a livestock extension agent's suggestion that they should learn to cut and stock grass and reduce the size of their herds to adapt to shrinking pastureland. This led to a heated discussion between farmers and herders on access to and availability of pasture, especially in lowland areas. The latter provide needed fodder for livestock at the end of the dry season, when there is no more grass elsewhere, but they are also increasingly being planted by farmers as insurance against drought.

- *Strategy for community level dissemination by representatives of each village (CFAR facilitator)*. Participants were divided in working groups, one per each village and one for the women. Plans formulated by the groups were reported to the whole assembly. Reports addressed what people had understood, how they would communicate it to their communities, and what possible strategies could be used to respond to the forecast. Participants also addressed questions such as how to deal with discrepancies between with local and scientific forecasts, how to reconcile differences in what people remembered, and how to deal with questions for which they did not know the answer.

Generally plans included a) a restitution meeting at village center/market (and/or individual village sections); and b) word-of-mouth at social events and common meeting places. Some discussion arose about the appropriateness of using the Friday mosque worship as for

dissemination (stricter Muslims stressed that only religious issues should be discussed at the mosque).

We believe that, beyond the practical advantage of having a plan, the collective, public formulation and articulation of a communication strategy also reinforces the participants' accountability to their communities (enhancing the likelihood that the information will be indeed shared).

- *Clarifications, and Q&A session (DMN, INERA, CFAR)* to rectify misunderstandings that emerged during the restitution and address additional questions. Many questions arose about the Operation Saga (a high profile government cloud seeding program) and its relation to the forecast.

A difficulty that arose during the various technical presentations and the Q&A session was the tendency of some presenters to go into a great deal of technical detail that interested educated participants (directors of extension and research services) and, likewise, the tendency of technicians attending the workshop to engage the presenters in a dialogue between 'experts'. This resulted in confusing and marginalizing farmers from the discussion. To avoid this problem, we had to ask the technicians to reserve their questions for the end, an arrangement that caused some discomfort given the prevailing institutional culture, in which educated officials are not used to defer to farmers. Generally, the pervasiveness of a conventional extension model that views farmers as receivers, rather than co-producers, of information and technology, had to be constantly kept in check. In the Central Plateau, the presence of the village chief during the first day of the workshop inhibited interventions by farmers, some of whom felt reticent to speak up in front of the chief (this was no a problem for less hierarchical cultures, such as the Bwaba of Bouahoun).

- *Opportunity for technical services and NGOs* operating in the area to explain what resources and services they offer to help farmers better apply the forecasts.

Additional dissemination efforts:

A *summary leaflet in local languages* (Moré, Fulfulde, and Dioula) was distributed to all workshop participants and village leaders shortly after the workshops (see Appendix 1). This was also a support farmers had requested during the post-harvest survey that followed the 2002 workshops, indicating that they felt more confident to have something written (which they, if literate, or their children could read) to remind them of the key points and to avoid disseminating misleading information if they did not remember correctly. They also stressed that being able to show a written document would also increase the credibility of the information vis-à-vis others to whom they passed it on.

A *radio communiqué with the updated forecast* was also broadcast in the local languages in late July-early August on locally-based FM stations (in Boulsa and Dori) for the Central Plateau and the Sahel and on a regional station (broadcasting from Bobo Dioulasso) for the Southwest site, where there are no local FM stations. The update showed a slightly more marked tendency toward normal or above normal rainfall than the preliminary forecast (35/45/20 for the North, 30/45/25 for the Centre, and 45/35/20 for the South). This corresponded to some extent to farmers' own observations of relatively abundant rainfall during the ongoing season. Although by the time they received the update, most planting decisions had been made (except for sesame and few other minor crops), farmers had indicated during previous surveys that updates are still useful for making decisions about management of food and cash resources and about labor allocation among various fields, and among farming, livestock, and non-farm work.

A team composed of DMN and INERA collaborators visited Villages 2 and 3 in each of the CFAR research areas in August to review data collected by the facilitators and by the rain gauge readers, and respond to questions farmers might have about the forecast at that point in the season.

Representatives of the media also assisted at the workshops, and reports on all three workshops were featured shortly after the workshops in the national government newspaper *Sidwaya* and in French broadcasts on the national radio (see attached article in Appendix 2). According to the DMN's policy, which approves for the forecast to be released only experimentally in the CFAR sites, and not broadly across the country, the journalists were asked to report on the concept of the forecast and on the general tendency for the upcoming rainy season, rather than the exact probability distribution.

Data collection:

At the end of the workshops, a meeting was held with the farmer rain gauge readers and micro-plot operators in all 3 villages in each area to review procedures and equipment issues. Balancing the need for precision required by meteorologists and the farmers' capabilities (both in terms of their literacy skills and of the time they can devote to observations and record keeping) remains a challenge.

On June 28-30, a research planning meeting, including CFAR researchers, facilitators, and DMN, INERA collaborators, was held in Ouagadougou to review the experience of the 2002 season and to plan for the research activities during the 2003 growing season. Modifications were made to research instruments and samples as follows:

Research instruments

- *Rainfall and temperature* data forms were adjusted to better enable cross-checking, and farmers were equipped with calendars in local languages to help them keep better track of dates.
- The *crop growth* and *yield* protocols for the micro-plots were considerably expanded to respond to the data requirements of the crop simulation models, which are more demanding than originally envisioned. Facilitators were given additional training in making these observations and measurements by the INERA collaborator involved in the modeling effort, Dr. Moussa Sanon.
- The *socioeconomic survey* was streamlined from three questionnaires, administered at different times of the farming season, to only one, to be administered after planting time. This change was brought about by various factors, including a) the desire not to excessively burden farmers during the busy time of the farming season; b) the difficulty of accessing some villages during periods of heavy rain; c) the need to compensate for the increased demand for agronomic data and the reduction in budget due to the loss of value of the US\$.

Samples

- *Rainfall and temperature* forms and crop growth and yield protocols will be completed for a sample of 6-7 farmers in all three villages (Levels 1, 2, 3) in each area, for a total of approximately 55-60 households. A few farmers with rain gauges were unable to continue due to migration or illness, so others were identified and trained. In a few villages one rain gauge was added to include village sections or social groups that had been left out in 2002.

- The *socioeconomic survey* involved farmers who did and did not participate in the workshop (21 each for Villages 2 and 3, and 14 for Villages 1, for a total of 168 households). The sample (which is purposively, not randomly, selected) was also slightly modified to correct political biases, achieve a better representation of Peul herders, and ensure that respondents were the primary decision-makers for their households' production strategies.

Several of the farmers who have rain gauges reported that many in their villages were interested in knowing about how much it rained during each rain event. Therefore we arranged for blackboards to be built and posted in a prominent place in each village, where rain gauge readers could report the levels of rainfall after each rain for everyone to read.

In an effort to better understand the role of the irrigation barrage in Bonam in the Central Plateau on crop production, data collection of elevation changes, releases, rainfall, and temperature continued there. Irrigation practices were also collected from interviews with some key farmers.

Crop model applications and capacity building:

Agro-meteorologist Ciriague Sia of DMN begun training on crop modeling and agrometeorology at the University of Georgia under the direction of Dr. Hoogenboom on February 1st 2003 and returned to Burkina Faso on May 31, 2003. Dr Sia used the data collected during the 2003 growing season from the raingages, microplots, soil samples, and socioeconomic surveys to evaluate the DSSAT crop simulation models for the major staple cereals produced in the three zones (maize, millet, sorghum). We found that the yield and biomass observations from farmers' fields were not very reliable and in many cases were much higher than locally reported regional levels. Further discussions with the facilitators are needed to determine the potential error in sampling and data collection. In order to evaluate the potential of using climate forecasts for crop model applications and yield forecasting, Dr. Sia also analyzed the long-term historical weather records from the main synoptic weather stations in Burkina. He was able to identify differences in rainfall patterns with respect to El Nino, La Nina and neutral years. Further analysis of the data is needed. Dr. Sia concluded his four-month visit to the University of Georgia with his participation in the 2004 Training Program on DSSAT Version 4: Assessing Crop Production, Nutrient Management, Climatic Risk and Environmental Sustainability with Simulation Models.

Following his training on crop modeling in 2002, Dr. Moussa Sanon conducted a planting date trial with several millet and sorghum cultivars at a Burkinabe research station in Di. The varieties represented local varieties grown by farmers in the villages that are part of the CFAR project. The main of this experiment was to obtain detailed phenological and growth information to help determine the cultivar coefficients for the crop simulation models. Dr. Sanon also analyzed representative soil profiles in each village. Further analysis of the soil samples are needed to determine soil texture and bulk density.

Dr. Gerrit Hoogenboom visited Burkina Faso from September 12 through 23, 2003. During his trip he visited the INERA Experiment Station in Di and evaluated the planting date trials of Dr. Moussa Sanon, met with local farmers in Hounde and visited several farmers' fields, and met with the administrators of INERA and DMN to discuss the current status of the CFAR project and opportunities for collaboration in future projects.

B. Summary of Preliminary Findings:

During this period efforts concentrated on data collection and analysis.

C. Papers and Presentations during this Period:

Kirshen, P., Ingram, K., Hoogenboom, G., Jost, C., Roncoli, C., Ruth, M., and Knee, K., Lessons Learned for Climate Change Adaptation; Part 1 - Implementation of Seasonal Climate Forecasting in West Africa; Part 2 - Impacts from and Adaptation to Climate Change in Metro Boston, USA (invited), Insights and Tools for Adaptation: Learning from Climate Variability, NOAA Workshop, 18-20 November 2003, Washington, DC.

Kirshen, P., Ingram, K., Hoogenboom, G., Jost, C., Roncoli, C., Taking Stock and Moving Forward; the Role of Seasonal Forecasting in Adaptation to Long-Term Climate Change, What the CFAR Project in Burkina Faso Has Learned , invited panel presentation at 2003 Open Meeting of the Human Dimensions of Global Environmental Change Research Community, Montreal Canada, 16-18 October 2003.

D. Significant Deviations from Workplan:

While significant accomplishments have been obtained, we made several adjustments to the proposed action plan to respond to collaborators' requests, changing field conditions, lessons learned, and procedural challenges.

1) Some modifications to the workshop format and venue were made, on the basis of the 2002 experience (see above, under Forecast Dissemination).

2) The substantial (30%) loss of value of the US\$ in relation to the Franc CFA that occurred between the time we elaborated the project budget and the present forced us to make some modification to the field activities (see above, under Data Collection). Thanks to the commitment and generosity of our Burkinabé facilitators and collaborators, these changes have been relatively minor.

3) Radio broadcasting plays a lesser role than originally anticipated because Burkina Faso has not yet elaborated an official national policy of forecast dissemination. The DMN considers the forecast to be too experimental to allow its broadcasting on national media. However SOFITEX has been broadcasting the forecast through private radio stations in the cotton growing areas, and local stations in the CFAR sites. Our socioeconomic surveys and post-harvest evaluation captured the impact of these programs and of other climate-rated broadcasts.

4) Support by extension and development agents was a key element in the original research design. However, during our field activities and interactions with farmers we realized that the potential role they could play was limited by several factors including: a) lack of resources available to government extension services (we decided against providing additional resources to provide services in the CFAR villages because the solution would not be sustainable); b) high staff turnover (extension agents that were trained during the 2002 workshop were shortly thereafter assigned to other zones); and c) language problems (because of regional imbalances in educational opportunities, some extension and development workers, especially in the Sahel, belong to different ethnic groups than farmers in the villages they serve and do not speak the local language). Due to these factors, government extension workers are not always an active and trusted presence among farmers. NGO workers are better equipped and more frequent in the villages but their scope of intervention and agricultural technical knowledge is often limited. On the other hand, we found that farmers tend to rely far more on other farmers than on extension workers for information and technological innovations. We therefore shifted our focus from extension workers to 'lead farmers' as the key intermediaries envisioned by our research design. These lead farmers are Level 3 villagers who are influential in the community by virtue of their social position and farming knowledge and who have participated in CFAR research activities and in the PRESAO Forum in 2000 (and therefore have a greater understanding of the forecast

parameters and limitations than other villagers). Some of them are among the 6 farmers in each village who hold and read the rain gauges.

5) We originally intended to have three villages in each zone representing different levels and types of forecast-related information and support. In order to do this we selected two villages (representing Level 2 and 3) in each site which had participated in CFAR activities during the project first phase, and added a third village (representing Level 1) where we had not worked before. During the first year (2002), these Level 1 villages were not involved in the workshops but are involved in other research activities (rain gauges, surveys, mid-season visit, post-harvest evaluation) through which information about the forecast filtered through, generating much interest among farmers. Consequently, after discussion with CFAR research facilitators and community leaders, we concluded that it would be socially and ethically problematic to exclude these villages from participating in the second year (2003) workshops. Although this represented an unbudgeted expense, we included 10 farmers from Level 1 villages in the 2003 workshops.

6) The delay in releasing the funds from NOAA to Tufts meant that we began field activities later than planned (after the onset of the rains). Therefore, we were unable to collect a full season of rainfall, agronomic, and socioeconomic data. Moreover, the delay meant that we were unable to bring the visiting scientist to the University of Georgia in Fall 2002 to work on crop modeling as originally planned. As funds became available in October we were only able to complete visa and travel procedures to bring the first scientist from Burkina Faso to the University of Georgia on January 31st, 2003 for a four-month training. Dr. Moussa Sanon was able to collect more specific agronomic, soil and weather information during the 2003 growing season, but no crop model-based yield forecast could be provided during the 2003 growing season. Depending on the outcome of the crop model evaluation with local on-farm data, we are planning to present the use of the crop models as a yield forecasting tool based on regional climate forecasts with other researchers, and non-farmer stakeholders in the planned 2005 end-of-project workshop.

IV. Relevance to Field of Human-Environment Interactions.

A. Use of Climate Data in Decision-Making: Through understanding farmer's behavior in response to the forecast and related information, we are seeking to improve the utility and effectiveness of climate data. During CFAR Phase 1 we documented farmers' climate information needs in terms of parameters, timing, and source. In this second Phase, in the course of the provincial workshops, we are experimenting with different representational forms and communication tools to convey notions of probability and forecasts limitations. In the course of the socioeconomic surveys and in-depth interviews we are analyzing the process of decision-making. However, we do recognize that farmers' decisions are very complex and entail consideration of many different factors, including but not limited to forecasts. In some cases decisions are based on farmers' performative knowledge, which may not be explicitly articulated but it is based on a combination of past experience, assessment of present environmental conditions, perception of available options, and household risk tolerance.

B. Building on Previous Research: This project directly builds upon the first phase of the CFAR research project (1997-2001) that examined opportunities and obstacles to forecast use in Sahel-Sudan information networks in the three zones of Burkina Faso. The project also capitalizes on the institutional relationships established by the USAID-funded Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program in Burkina Faso (1994-1997). Our work also builds upon and contributes to the knowledge generated by NOAA and other HD-funded research projects on similar topics in other regions.

C. Contribution to Other Areas: 1. **Adaptation to Long-Term Climate Change.** Our research seeks to understand how forecasts are used to respond to interannual climate variability. However, the repertoire of adaptive responses enacted by farmers and herders includes technologies and strategies that have been adopted to cope with perceived longer term climate fluctuations (i.e. adoption of shorter cycle varieties from northern, drier regions of the country). An understanding of the dynamics of diffusion and adoption of such adaptations will contribute to the formulation of policies and approaches that support farmers' adaptive capacity.

2. **Natural Hazards Mitigation:** The extended timeframe of our research in Burkina Faso has enabled us to witness the impact of and response to climate extremes, such as flooding in the Southwest in 1999 and severe droughts in the Central Plateau in 1997 and 2000. Through household level surveys and intensive interviews we were able to document how differently-endowed households were affected and how differently-positioned social actors (men, women, farmers, herders) responded. We were also able to highlight the trade-offs and compromises entailed in adaptation and to formulate recommendations for policies that promote long-term sustainable development over short-term survival.

3. **Institutional Dimensions:** CFAR Phase 1 begun with an institutional analysis of the potential for use of forecasts in planning, resource allocation, development assistance, relief interventions, etc (published in Natural Resources Forum, Aug 2000). Many of those findings are still valid although we have continued updating our understanding throughout the research process. We are documenting shifts in institutional policy and practice that affect farmers' access to resources and information that they need in order to optimally use forecasts. These include changes in SOFITEX credit and input provision policies, the onset or end of development projects, the creation of new farmer organizations, and the redefinition of administrative boundaries (which determine villagers' access to NGO resources and government services).

4. **Economic Value of Forecasts:** Assessing economic impacts of the forecast is hindered by the fact that farmers in at least two of the zones (the more commercialized Southwest being the exception) do not measure acreages, yields, and inputs (seed, manure, etc) precisely. Most factors of productions in all three zones (land, labor, and inputs) are not commoditized, and crop and animal prices vary seasonally. However, by using proxies and relative values we arrived at an estimate of gain or losses for farmers that reported changes in production practices due to the forecast.

5. **Decision Tools:** The crop modeling component will provide a key decision support tool. Modeling results will be presented and packaged in different ways to enable farmers as well as other stakeholders to use the information to make decisions.

6. **Sustainability:** All forecast dissemination approaches and application strategies that we are testing are sustainable in the long run given the level of resources available to the institutions, stakeholders, and farmers involved. Therefore we have avoided solutions that cannot be sustained (i.e. paying extension workers to act as intermediaries). Participation in the project is increasing research and technical capacity of collaborating institutions and stimulating greater interaction among various institutions (Meteorological Services, agricultural research, development NGOs, and extension services). The project has been successful in promoting a user-relevant, demand-driven research agenda and participatory methodologies that enable scientists to learn from farmers.

7. **Scientific/ Local Knowledge:** Farmers use a repertoire of forecasting techniques to formulate expectations relative to the rainy season. Generally they do not rely on any of them in making

decisions on crop and livestock management until they are verified against what is considered the most reliable indicator, namely the timing and nature of the onset of the rains. Farmers consider their own forecasting techniques to have become less reliable because of perceived greater climate variability during the last 30 years. Therefore they are open and interested in receiving scientific forecasts. Combining indigenous and exogenous knowledge systems is not new to farmers who are used to rely on both local and scientific solutions in agriculture, health, etc. Customary leaders and Islamic imams are not opposed to introduction of scientific forecasts and are willing to collaborate with dissemination efforts as long as the information is presented in ways that respects their beliefs and their prerogatives.

8. **Public Policy:** Burkina Faso does not have an official national policy of forecast dissemination. The perception of the forecast as still ‘experimental’, the potential political liabilities from the possibility that the forecast may ‘fail’ and result in economic losses and popular discontent, might also shape forecast dissemination policy.

9. **Socio-Economic Impacts of Decadal Climate Variability:** Farmers in the three zones perceive that a change in climate has occurred since the 1970s in terms of decreased rainfall, shortened rainy season and erratic rainfall patterns (farmers lament that ‘the rains have become like the national lottery’). Adaptive strategies adopted by farmers and herders have resulted in exacerbating tensions between the two groups (i.e. farmers have responded by expanding planted areas in lowlands that provided much needed pasture during the late dry season, herders have diversified into agriculture and compete with farmers for land). The expansion of acreages to compensate for lower productivity also produces greater competition for land between original residents and immigrant farmers and herders in the Southwest.

10. **Other:** Despite much effort in ensuring equity and inclusivity in all aspects of the project, we could not entirely prevent local social cleavages to shape participation in the workshops and research activities. Knowledge is power, especially when associated with access to (even modest) resources and contacts with outsiders. Some level of marginalization along social and political lines did occur. The imbalance generally favored agriculturalists over pastoralists, even when the latter belonged to a higher caste. In some cases Peul herders were not able to participate in the workshop and did not receive the forecast during village level dissemination. ‘Noble’ Peul herders were also left out when government appointed village leaders belonging to the formerly-enslaved Rimaibé caste. Local political disputes and/or competition for land were also played out in selection of contact farmers and workshop participants. We are incorporating these learnings in planning for the third year activities as well as preparing to analyze those issues in a paper to be submitted to a pastoralism-focused journal.

V. Graphics.

We have supplied CDs with copies of Power Point presentations and photos of fieldwork to OGP.

VI. We have no website.

Appendix 1: Flyer summarizing seasonal forecast for 2003

PRÉVISION DE PLUVIOMÉTRIE POUR JUILLET, AOÛT, SEPTEMBRE 2003

Le Service de la Météorologie Nationale se base sur des observations de la température de la surface de la mer et de la pluviométrie pour faire des prévisions sur la pluviométrie de Juillet, Août et Septembre. Ces observations bénéficient d'une base de données acquise sur plus de 30 ans.

Cette prévision peut déterminer si la tendance va être normale, plutôt humide ou plutôt sèche. La prévision pour Juillet, Août, et Septembre 2003 indique la probabilité d'une pluviométrie moyenne (normale). Mais il y a aussi une possibilité qu'elle soit sèche ou humide.

30 % humide

40 % moyenne (normale)

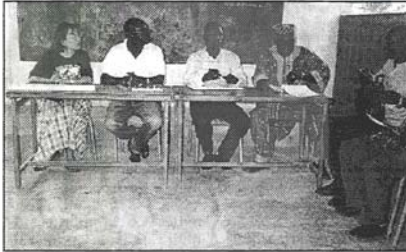
30 % sèche

- La prévision concerne la pluviométrie pendant les mois de **Juillet, Août et Septembre**. C'est vrai que la campagne peut commencer en Mai ou Juin et finir en Octobre, mais la Météo ne peut pas prévoir la pluviométrie en début campagne (Mai et Juin) et en fin de campagne (Octobre).
- La prévision concerne la **quantité totale de pluie** qui tombe pendant Juillet, Août, et Septembre. La Météo ne peut pas prévoir comment la pluviométrie va se répartir pendant les trois mois, ou s'il y aura des poches de sécheresse.
- La prévision est relative à **une zone** du pays. Le pays est divisé en trois zones : Nord, Centre, et Sud. Votre village est dans la zone La Météo ne peut pas prévoir comment la pluviométrie va se répartir entre les différents villages de chaque zone.
- La prévision exprime une **probabilité**. Même si on dit que la tendance est vers la normale, ça peut arriver que la pluviométrie de Juillet, Août et Septembre soit sèche ou humide.

Une mise à jour de cette prévision sera diffusée avant la fin de Juillet.

Résultats sur les prévisions pluviométriques saisonnières

L'atelier organisé par le CFAR (Climate Forecasting and Agricultural Ressources) a permis aux chercheurs internationaux, nationaux et locaux d'échanger à Boonam les 19 et 20 juin 2003 sur les prévisions saisonnières de 2003. Cette année connaîtra, selon les probabilités des uns et des autres, une pluviométrie à 40% normale.



De gauche vers la droite, Mme Clara, le directeur de la météo, le directeur Plan/Kourittenga Namentenga, le député Kaboré Paté, Salam Dahadjo

L'objectif du 3e atelier du genre organisé au Namentenga par le CFAR projet en partenariat entre l'Université de Géorgie, l'université de Tufts aux Etats-Unis, la Direction de la météorologie nationale, l'Institut national de l'Environnement et des recherches agricoles

(INERA) et l'ONG Plan-Burkina était de permettre aux chercheurs endogènes et exogènes d'échanger entre autres, sur les probabilités de la pluviométrie saisonnière de l'année et sur les stratégies à adopter pour une amélioration de la production agricole et de la sécurité alimentaire.



Photo de famille

En rappel, les probabilités portent sur les mois de juillet, août et septembre. Les probabilités de 2002 ont été réalisées. Celles de 2003 sont analogues à celles de 1989. Abordant la restitution de leurs recherches, l'équipe technique, de la météorologie a fait comprendre aux participants la notion de probabilité. Des jeux de simulation ont étayé la compréhension. Retenons que si le degré de réchauffement des eaux de la mer constitue le repère des chercheurs exogènes, l'état de production des arbres, le sens de la progression de l'hivernage constituent des repères pour les endogènes.

Ainsi, l'équipe de la météorologie dira qu'en ce qui concerne le Plateau central du Burkina Faso, les probabilités sur la pluviométrie saisonnière de 2003, les tendances vont de 30% d'excédent, 40% à la normale et 30% déficitaire. La répartition spatiale et temporelle reste indéfinie. Pour les chercheurs endogènes (traditionnels) de Boonam, les signes observés présagent une bonne pluviométrie. Les producteurs de Boonam, Tanguin et de Boala ont été dotés depuis 2002, d'outils indispensables (thermomètres et pluviomètres) par le CFAR pour

faire des relevés en vue de constituer leurs banques de données sur le climat de leur région. M. Salam Bahadjo supervise les actions du CFAR du Namentenga.

Planchant sur l'éventualité d'une pluviométrie excédentaire ou déficitaire, les participants ont adopté des stratégies pour que l'un des cas n'entrave pas la sécurité alimentaire.

L'équipe du CFAR conduite par Mme Clara s'est réjouie des résultats des travaux. A son tour, elle a reçu les encouragements de M. Kaboré Paté, député à l'Assemblée nationale, chef du village du Boonam □